

Nathaniel “Natey” Kim

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RESEARCH INTERESTS

My research goal is to develop assistive and rehabilitation robots that bridge the gap between humans and machines, enabling robotic systems to function as intuitive extensions and partners in human activity. My interests span both physical and cognitive human–robot interaction, including human movement analysis, upper-limb exoskeletons, musculoskeletal modeling, human-in-the-loop control, and social robotics.

EDUCATION

University of Pennsylvania

May 2026

- **M.S.E. in Robotics** (submatriculation), GPA: **4.0/4.0**

Master’s Thesis: *Musculoskeletal Digital Twin Model for Real-Time Human-in-the-Loop Feedback Control Systems*

Advisor: Dr. Nadia Figueroa

- **B.S.E. in Bioengineering**, GPA: **4.0/4.0**

PUBLICATIONS

Maggie Wagner*, Sanghyub Lee*, **Nathaniel Kim***, Michael North*, Nadia Figueroa, Josh Baxter, and Flavia Vitale. “Latent HD-sEMG Representation Learning for Achilles Tendinopathy Assessment.” Pending submission to *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 2026.

Sanghyub Lee, **Nathaniel Kim**, Dhyey Shah, Jason Chen, and Nadia Figueroa. “Musculoskeletal Digital Twin Modeling for Biomechanical State Estimation During Weighted Elbow Flexion.” Under review for *2026 IEEE-RAS International Conference on Humanoid Robots (Humanoids)*.

RESEARCH EXPERIENCE

University of Pennsylvania GRASP Laboratory — Research Engineer

Aug 2023 – Present

Hybrid Simulation- and EMG-Controlled Exoskeleton

Jun 2025 – Present

- Developed a MyoSuite musculoskeletal digital twin using inverse dynamics, PD control, and quadratic programming, reproducing measured elbow kinematics with a mean tracking RMSE of 1.866°.
- Developed a causal temporal convolutional network that predicted subject-specific biceps and triceps EMG for unseen controller configurations with mean NRMSEs of 10.7% and 10.5%, respectively, at real-time latency.
- Integrated surface EMG, OptiTrack motion capture, motor torque, and exoskeleton encoder data across three participants, four external loads, and five controller configurations.

EMG-Based Achilles Tendinopathy Classification

Aug 2023 – Present

- Developed a real-time high-density EMG collection pipeline using custom 3D-printed hardware and laser-cut MMX/silicon fabric electrodes for movement and injury analysis.
- Built a 3D variational autoencoder to quantify Achilles tendinopathy severity, assess injury laterality, and classify rehabilitation exercises from high-density EMG.
- Detected Achilles tendinopathy in an average of 20 of 21 held-out evaluations and correctly classified healthy, unilateral, and bilateral pathology in 18 of 21.

PRESENTATIONS

Penn Undergraduate Research Mentoring Program Symposium — Presenter

2024

- Presented “From Muscle Signals to Motion: A Deep Learning Approach to Human Movement Prediction,” describing a real-time GRU pipeline that predicted movement completion from surface EMG with a mean absolute error of 3.49%.

*Equal contribution.

PROFESSIONAL EXPERIENCE

- Maingen (Y Combinator)** — Resident Researcher Jul 2026 – Present
- Research machine-learning methods for generating and optimizing robotic end-effector CAD geometries using simulation-derived performance requirements.
 - Develop simulation and evaluation pipelines for assessing generated designs through geometric validity, mechanical performance, and task-specific engineering constraints.
- Tadashi Robotics** — Founding Mechanical Engineer Aug 2025 – Present
- Translate Ember from an academic social-robotics research platform into an early-stage product for rehabilitative patient support and naturalistic human–robot interaction.
 - Designed the mechanical enclosure and embedded architecture, integrating wireless communication, audio I/O, vision, display, power, and motor-control hardware.
 - Developed LLM-based interaction logic for reminiscence dialogue and emergency guidance and authored human-subject and non-human-subject IRB submissions supporting studies of Ember.

RESEARCH & DESIGN PROJECTS

- Verdigris: Assistive Ultrasound Guidance Device for Lumbar Puncture** Aug 2025 – May 2026
- Co-developed an assistive medical device using ultrasound-based bone detection and real-time angle feedback to guide clinicians toward viable lumbar puncture needle trajectories.
 - Designed the device enclosure and visual interface, integrated the ultrasound transducer, motor, needle-angle sensor, and control electronics, and conducted acoustic signal acquisition testing on tissue and spinal phantoms.
 - Validated angle sensing and LED feedback to within 1° across controlled targets; contributed to a benchtop prototype achieving 80% optimal needle-path detection and 95% bone-detection accuracy.
- Rehabilitative Driving Simulator** Jan 2023 – May 2023
- Collaborated with engineers and clinicians in Jamaica to develop a Unity-based driving simulator with custom steering and pedal controls for pediatric patients with hemiplegia.

TEACHING & MENTORSHIP

- The Salvation Army** — Volunteer Tutor & Youth Mentor Dec 2022 – Present
- Founded and taught a 3D-printing course, tutored students in STEM subjects, and prepared students for competitive high-school entrance examinations.
 - Mentored students in exploring career pathways in technology policy, computing, robotics, and game design.
- Bioengineering M.A.D. Laboratory I & II** — Teaching Assistant Aug 2025 – May 2026
- Helped develop laboratory curriculum and instructional materials for MATLAB-based bioengineering modeling and design.
 - Supported lab instruction through debugging, individual guidance, office hours, and exam reviews.
- BOLD Summers** — Residential Advisor & STEM Mentor May – Aug 2024; May – Aug 2025
- Mentored high-school students through individualized research, college, and STEM-career guidance while designing and facilitating academic, professional-development, and community programming.

TECHNICAL SKILLS

Programming & Tools: Python, MATLAB, C#, MicroPython, ROS, MuJoCo, Unity, PyTorch, scikit-learn
Modeling & Control: Machine learning, musculoskeletal modeling, inverse dynamics, quadratic programming, feedback control
Human Data Collection: Surface and high-density EMG, OptiTrack motion capture, acoustic signal acquisition, biosignal processing, human-subject research
Design & Fabrication: SolidWorks, Onshape, Rhinoceros 3D, circuit design, 3D printing, laser cutting

HONORS & AWARDS

- Hugo Otto Wolf Memorial Prize, Penn Engineering** 2026
- Received a \$500 prize recognizing exceptionally thorough and original work by a Bioengineering senior.
- Career Services Summer Funding Award** 2025
- Awarded \$5,000 in competitive funding to support full-time summer research.
- Penn Undergraduate Research Mentoring Program (PURM)** 2024
- Selected for a \$5,000 faculty-mentored undergraduate research award at the University of Pennsylvania.